Forest Road Sediment and Drainage Monitoring Project Report for Private and State Lands in Western Oregon

February 20, 1998

Prepared for:
Oregon Department of Forestry
Salem, Oregon

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Summary

This is the second report completed as part of a four-year project to investigate the effectiveness of forest road drainage practices designed to minimize sediment delivery to streams. This investigation is expected to yield a list of recommended road drainage and construction practices for private and public forest land managers and agencies that regulate forest management activities in western Oregon. This report summarizes data collected during the summer and fall of 1995 and 1996, years two and three of this project. Road drainage and sediment delivery data were analyzed in a regional context, as well as broken into categories based on best management practices (BMP's). A final technical paper will be produced at the end of this project.

Objectives

1. Develop field methods that determine the sediment delivery potential from forest roads.
2. Survey discharge structures and their potential for sediment delivery to waters of the state on forest roads in each of the five western Oregon georegions.
3. Develop a forest road inventory and erosion hazard inventory protocol for landowners.
4. Develop a road management guidebook.
5. Develop a technical issue paper for the Board of Forestry.

Background

Forest roads are recognized as the greatest potential source of accelerated erosion associated with forest management. The original intent of this four year monitoring project was to evaluate the effectiveness of Oregon's forest practice standards to minimize delivery of surface erosion from forest roads to waters of the state.

The February 1996 storm caused many landslides, channel changes, and other effects to natural resources and private property in northwestern Oregon. The storm was an unusual, but extremely important event that provided a unique opportunity to test the effectiveness of forest practices developed over the last two decades.

This report summarizes monitoring activities conducted during the summer and fall of 1995 and 1996. The data set reflects years when the relative importance of chronic surface erosion versus episodic landslide erosion as sources of sediment may have differed.

Methods

This report includes data that was collected during the summer and fall of 1995 and 1996. The method used to select areas to be surveyed differed each year. In 1995, all accessible roads within a randomly selected township, range and section were sampled to obtain at least 10 miles of road length. Where the randomly selected area (township, range and section) did not contain 10 miles of road, the sampling boundary was extended until that length of road was encompassed. Land in federal ownership, agricultural or urban landuse or dominated by large waterbodies was not sampled.

Areas sampled in 1996 were chosen using two different methods. First of all, three 10 square-mile areas of the highest landslide density observed after the February 1996 storm were selected non-randomly by the Oregon Department of Forestry (ODF) and are called the "red" zones. Secondly, areas of similar landscape, climate and geology but with low-landslide density were identified and three areas were randomly selected from these areas, one to pair with each of the "red" zones.

Forest roads in each of the five western Oregon georegions were sampled in 1995. During the 1996 survey, only three georegions were sampled (Coast Range, Interior, Western Cascades), thus the South Coast and Siskiyou georegions are represented by only the 1995 data. The Oregon forest practice rules (ODF 1997) use the term "geographic region" to describe large areas with similar climate, geomorphology and natural vegetation. There are five geographic regions in western Oregon:

1) Coast Range – Characterized by marine sandstone geology, high annual rainfall and steep coastal mountains.
2) Western Cascades – Characterized by volcanic geology, high annual rainfall and is generally mountainous.
3) Interior – The foothills on either side of the Willamette Valley.
4) South Coast – An area of unique geology and hydrology in Oregon that consists mainly of sheared metamorphic rocks and has the highest instantaneous maximum streamflows in the state.
5) Siskiyou – Highly variable geology and average annual rainfall ranges from 20 to over 100 inches.

Information gathered

The same methods were used to collect data in both 1995 and 1996 although the codes used for some road classifications and characteristics differed slightly. The data gathered included:

1) Road characteristics;
2) Condition of sample road segments (between surface discharge points); and
3) The location of surface water discharge points, including their potential to deliver sediment to waters of the state.

1) General Characteristics

The following data was collected to characterize the road:

a) Legal description (section, township, range) and name;
b) Forest practices maintenance status (active, inactive or vacated); and
c) Road surfacing material (clean rock, dirty rock or dirt).

2) Source Area

The source area of a surface water discharge point is the length of road draining to that point. Information was gathered for every road segment in the survey area. The information collected was used to evaluate the potential of the road to generate sediment for delivery to a surface water discharge point. This information was also used to evaluate road BMP's for erosion control and dispersal of surface waters.

The length and slope of each road segment was measured. Road design was categorized as crowned, insloped or outsloped. The condition of the ditch and the height and vegetative cover of the cutslope were also determined.

3) Discharge

Surface drainage points from the road include cross-drainage culverts, live stream crossings, waterbars, rolling dips, grade breaks, saddles, and random points of discharge. Information on drainage characteristics and potential sediment delivery at all surface drainage points was collected.

The diameter of all cross-drainage and live stream crossing culverts was measured. Culvert condition was estimated as the amount of the culvert inlet remaining open expressed as a percent. Where the culvert inlet was reduced, the cause was recorded as mechanical crushing, filling by debris or age related deterioration.

The culvert outlet or other discharge point was examined for evidence of sediment delivery to waters of the state. Discharge directly into a stream or a gully connected with a stream was rated a "yes" for delivery. Discharge points with either no evidence of erosion or deposition at the outlet or no evident pathway for sediment to enter the waters of the state were rated "no" for sediment delivery. All other discharge points rated "possible" for sediment delivery.

4) Data Collection

The length of each road segment was measured using a distance measuring instrument (DMI) that was installed in the vehicle and recorded distance in feet. A hip chain was used for distance measurements when roads could not be driven. A clinometer was used for slope measurements.

1995 Survey Comparison

This report summarizes the combination of the 1995 and 1996 ODF forest road drainage and sediment delivery surveys. The 1995 data is summarized in a 1996 report to the Department of Environmental Quality (ODF 1996a). To the length of road surveyed in 1995, 61 miles (324,141 feet) were added to the Coast Range georegion, 72 miles (380,876 feet) were added to the Interior georegion and 28 miles (148,278 feet) were added to the Western Cascade georegion by the 1996 survey. No survey data was collected in 1996 in the Siskiyou or South Coast georegions. The number of surface drainage discharge points surveyed approximately doubled from 1,398 to 2,810.

Delivery to Streams

Of the 285 miles (1,506,067 feet) of forest road surveyed in the five georegions, 25 percent drained directly to streams and another 6 percent were rated "possible" for sediment delivery. A total of 31 percent of the road length surveyed had a "yes" or "possible" delivery rating. Within the georegions, the combined "yes" and "possible" ratings ranged from 23 percent of the length of roads surveyed in the South Coast up to 47 percent in the Siskiyou georegion.

Spacing of Drainage Systems

The spacing between surface drainage discharge points ranged from 0 feet (culvert installed at a high point in the road) to 7,516 feet. The average spacing between surface drainage discharge points was 455 feet for all georegions and ranged from 293 feet in the Siskiyou georegion to 512 feet in the Interior georegion. The average segment length of roads with a grade greater than 18 percent was 284 feet and increased to 538 feet on roads with grades of 5-8 percent.

The spacing between points of surface road drainage (road segment length between drainage points) was compared with the spacing recommended by Arnold (1957). Arnold's spacing criteria was developed based on experience in the Western Cascades. The spacing of inventoried drainage structures was compared with Arnold's recommended spacings for a silt-loam soil and a 1-2 in/hr rainfall intensity.

Table 3: Arnold's (1957) recommended forest road drainage spacings for a silt loam soil receiving 1-2 inches/hr of rainfall.

Slope Class	Excessively Spaced Segment (ESS) Criteria (ft)
0 – 4	1500
5 – 8	865
9 – 12	480
13 – 18	335
>18	250

South Coast georegion. The first two segments upslope of live stream crossings accounted for 74 percent of the length connected to waters of the state, though this proportion ranged from 90 percent in the South Coast georegion to 41 percent in the Siskiyou georegion. The average length of road segments that were rated "Y" or "P" and were located upslope of stream crossings was 475 feet for the whole database, 373 feet for the South Coast georegion and 502 feet for the Siskiyou georegion. This average length is only 20 feet more than the average road segment length for the entire database.

Road segments that were rated "Y" or "P" for sediment delivery, were directly upslope of stream crossings and were excessively spaced comprised 9 percent of the entire database. These excessively spaced segments constitute 42 percent of segments rated "Y" or "P" for sediment delivery that are adjacent to streams, which is not substantially different from the proportion of excessively spaced road segments in the entire road survey database (40 percent). Thus, the occurrence of drainage spacing that exceeds Arnold's spacing criteria is similar for both segments rated "Y" or "P" for sediment delivery upslope of stream crossings and for elsewhere in the road network. However, the small sample size of this group of data suggests that such conclusions be drawn with caution.

Drainage System Characteristics

There were 2,810 surface drainage discharge points surveyed that drained 3,308 road segments (some surface drainage discharge points drained two road segments). Of these surface drainage discharge points, 714 (25 percent) were cross-drain culverts, 498 (18 percent) were live stream-crossing culverts and 18 (1 percent) were bridges. Additional drainage points included 306 waterbars, 305 ditch relief points, 210 grade breaks and 54 "other" drainage features. Non-engineered surface drainage occurred at 398 points and represented 14 percent of the data.

The majority (58 percent) of the drainage points rated "Y" or "P" for sediment delivery to waters of the state were live-stream crossing culverts. Another 19 percent of the drainage points that delivered to streams were cross-drain culverts. Non-engineered or random drainage points were less than 10 percent of the drainage points that delivered sediment to streams. The average road segment length that was drained by cross-drain culverts or live-stream crossing culverts was not appreciably different from the average for the entire database.

Over half (56 percent) of the live-stream crossing culverts were completely open and 10 percent were at least 51 percent obstructed. The degree of obstruction ranged from 91 percent of live-stream crossing culverts in the South Coast georegion that were completely open to 39 percent in the Coast Range georegion. Only 46 percent of all cross-drain culverts were completely open and 14 percent were at least half blocked. Nineteen percent of the cross-drain culverts surveyed in the Siskiyou georegion were completely open and 28 percent at least half blocked as compared to 78 percent being completely open in the South Coast georegion. However, this data represents a small

sample size of cross-drain culverts and live-stream crossing culverts in the Siskiyou georegion compared to the other georegions.

Table 5: Summary of road drainage features inventoried.

Drainage Type	Number	Percent
Cross-Road Culvert (Single)	714	25
Cross-Road Culvert (Multiple)	3	0
Stream-Crossing Culvert (Single)	498	18
Stream Crossing Culvert (Multiple)	10	0
Bridge	18	1
Ditch Relief	305	11
Water Bar	306	11
Non-Engineered Relief	398	14
Grade Break	210	7
Road Junction	290	10
Outsloped Road Construction	4	0
Other	54	3
Total	2,810	100

Table 6: Summary of road segment data by drainage feature type for the entire database and for segments definitely or possibly connected to waters of the state.

Drainage Feature	Entire Database				Possible and Positive Sediment Delivery to Channels					
	Discharge Length (ft)				Drainage Feature (DF)		Discharge Length			
	No. Rd. Segments	Total Length (ft)	Avg (ft)	% of Total	No. DF	% of Total (of DF)	No. Rd. Seg.	Total Length (ft.)	Avg. (ft.)	% of Total (of DF)
Cross-Road Culvert (Single)	861	424,269	493	28	158	5 (18)	181	89,544	495	6 (19)
Cross-Road Culvert (Multiple)	4	2,601	650	0	2	0 (0)	2	601	301	0 (0)
Stream-Crossing Culvert (Single)	619	292,015	472	19	493	15 (58)	613	287,277	469	19 (62)
Stream Crossing Culvert (Multiple)	15	11,097	740	1	10	0 (1)	15	11,097	740	1 (2)
Bridge	22	11,629	529	1	13	0 (2)	14	5,762	412	0 (1)
Ditch Relief	324	180,046	556	12	22	1 (3)	23	11,812	514	1 (3)
Water Bar	309	67,429	218	4	55	2 (6)	55	11,994	218	1 (3)
Non-Engineered Relief	499	164,588	330	11	74	2 (9)	89	32,168	361	2 (7)
Grade Break	285	141,913	498	9	4	0 (0)	6	2,526	421	0 (1)
Road Junction	299	190,434	637	13	14	0 (2)	15	7,228	482	0 (2)
Outsloped Road Construction	4	1,109	277	0	0	0 (0)	0	0	0	0 (0)
Other	67	18,937	282	1	9	0 (1)	11	2,099	191	0 (0)
Total	3,308	1,506,067	455	100	854	31 (100)	1,024	462,108	451	31 (100)